Towards Co-Production of Seasonal Forecast Products for Fire Managers in Alaska

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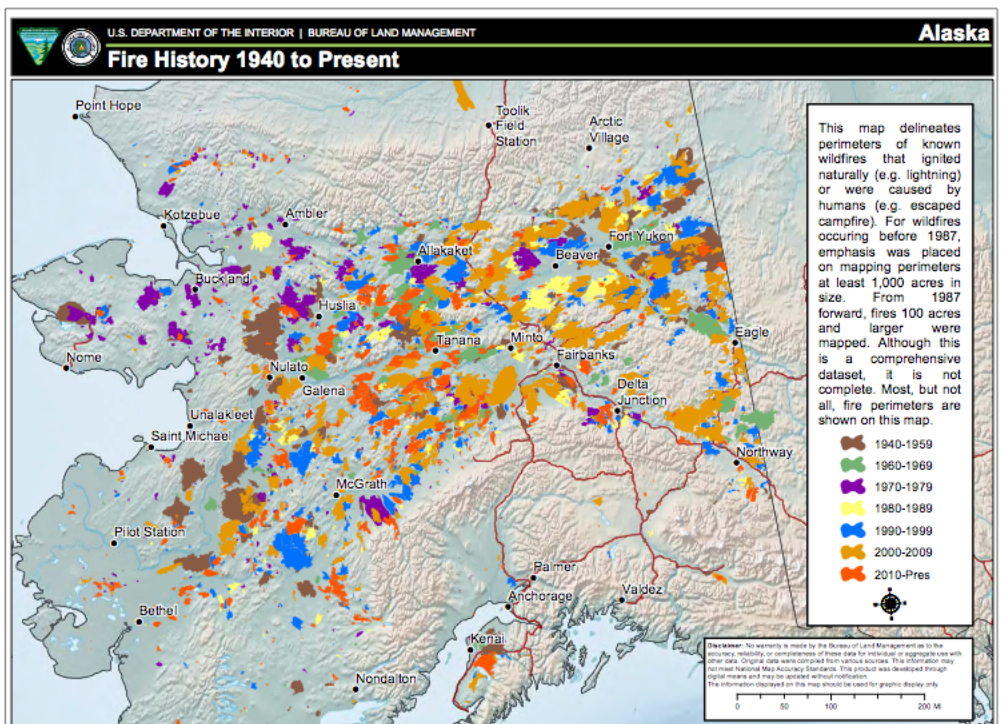
Tuesday April 24, 2018, Webinar

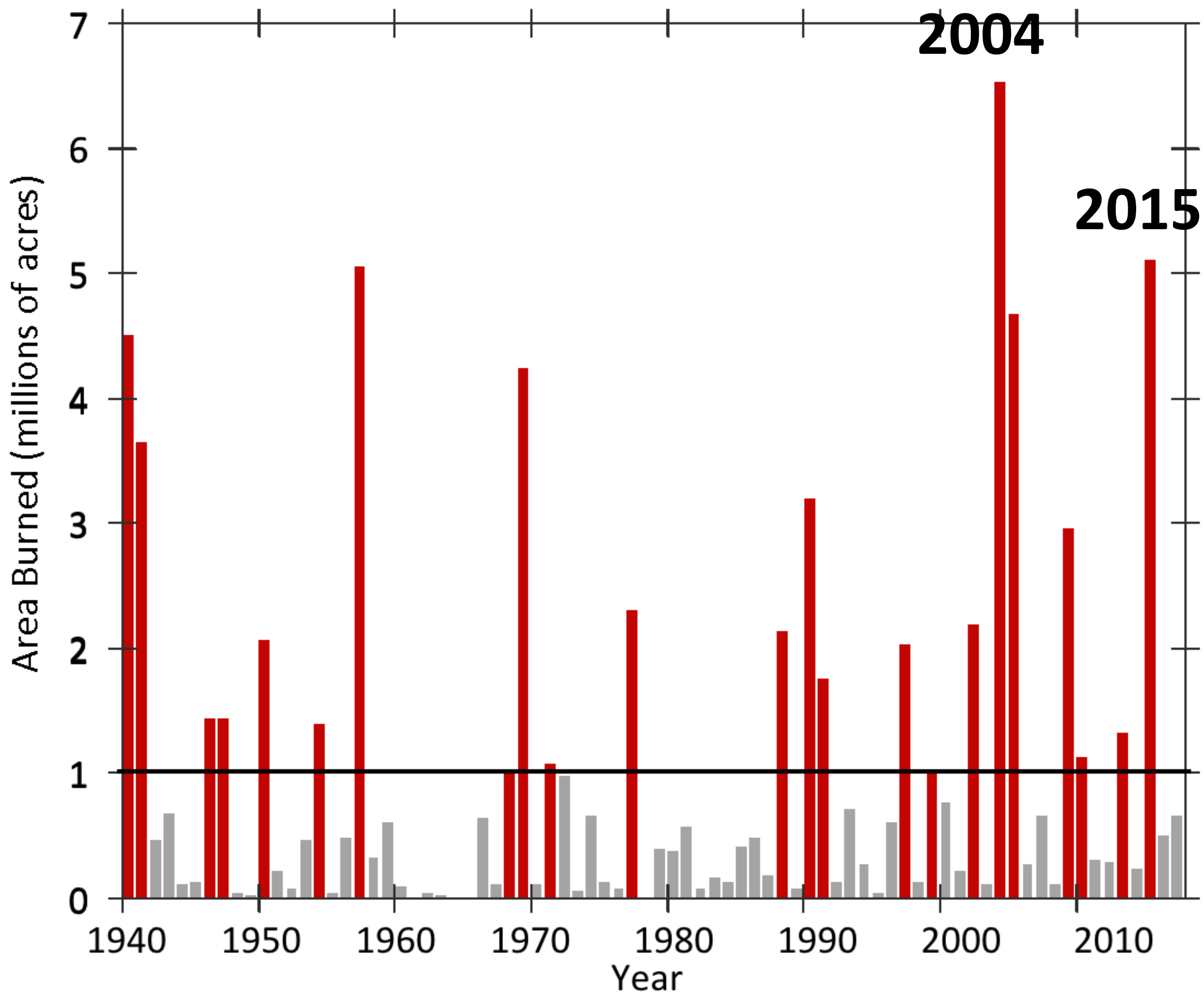
- **Goal: Use seasonal forecasts to make products for decision support several months before fire season.**



<u>Challenging</u>

Motivation

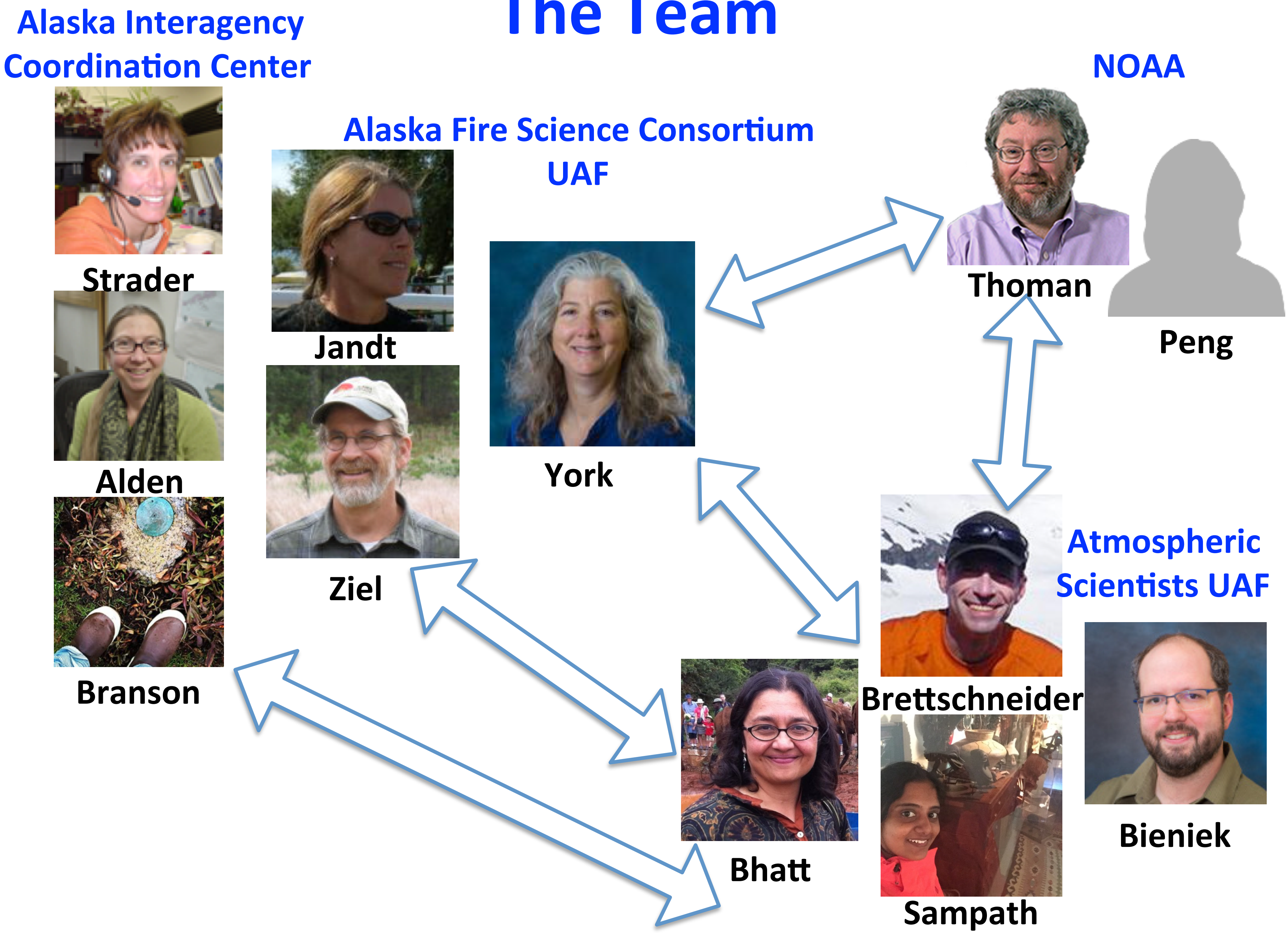
- Boreal wildland fire in Alaska **burns many acres**.
- Fires are **costly** (e.g., The record fire year of 2004 resulted in 6.5 million acres burned and was costly from property loss (> $35M) and emergency personnel (> $17M).
- **Information a season in advance** (March), save $ by allocating resources more effectively. Shrinking budgets …



Acres burned in Alaska

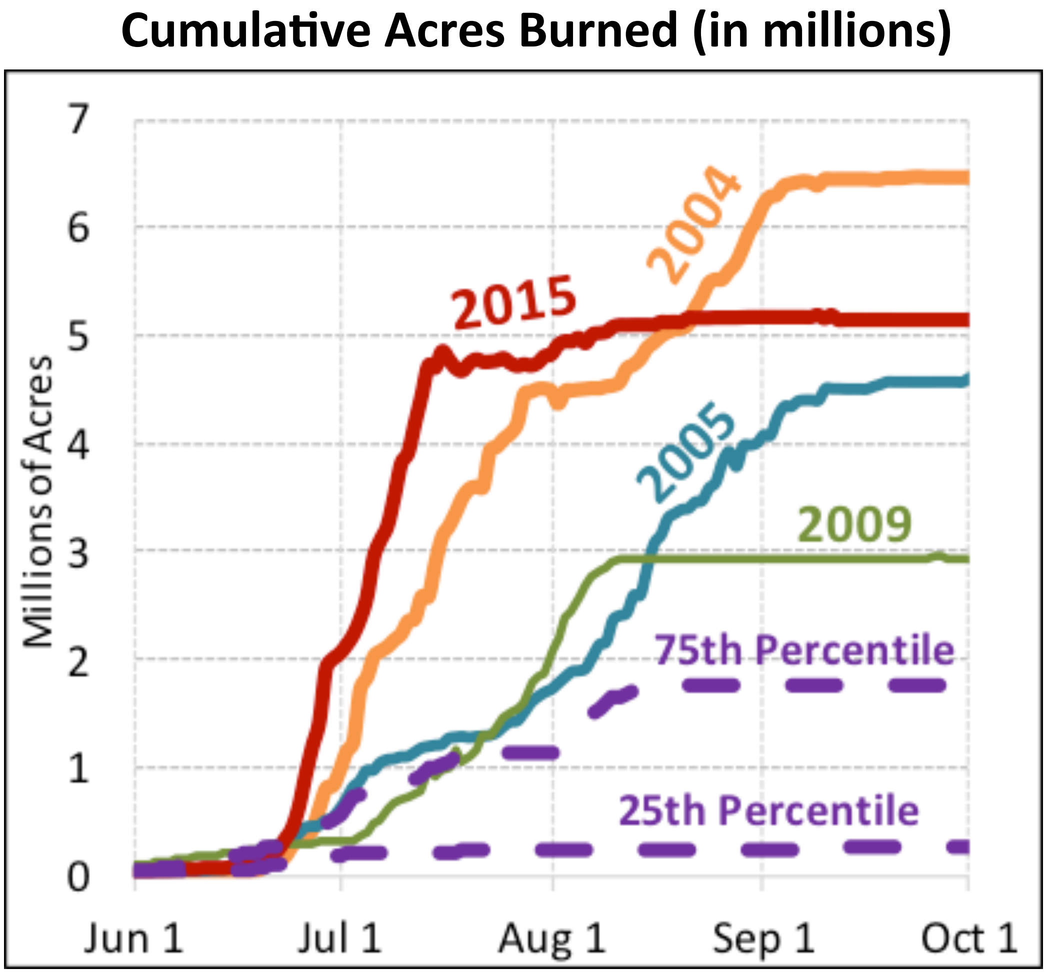
[Updated from Partain et al. 2016]

The Team


Alaska Interagency Coordination Center
Strader
Alden
Branson
Alaska Fire Science Consortium UAF
Jandt
Ziel
York
NOAA
Thoman
Peng
Atmospheric Scientists UAF
Brettschneider
Bhatt
Sampath
Bieniek

Acres burned vary within season in Alaska

- Wildfire season begins when the snow melts. (acres burned not related to snow amount)
- Less dependent on long-term drought & more on weather during fire season
- May and June are relatively dry (remember Interior Alaska is a polar desert)
- Mid-July, summer rains come and reduce fire risk
- Intra-seasonal weather variability determines total acres burned

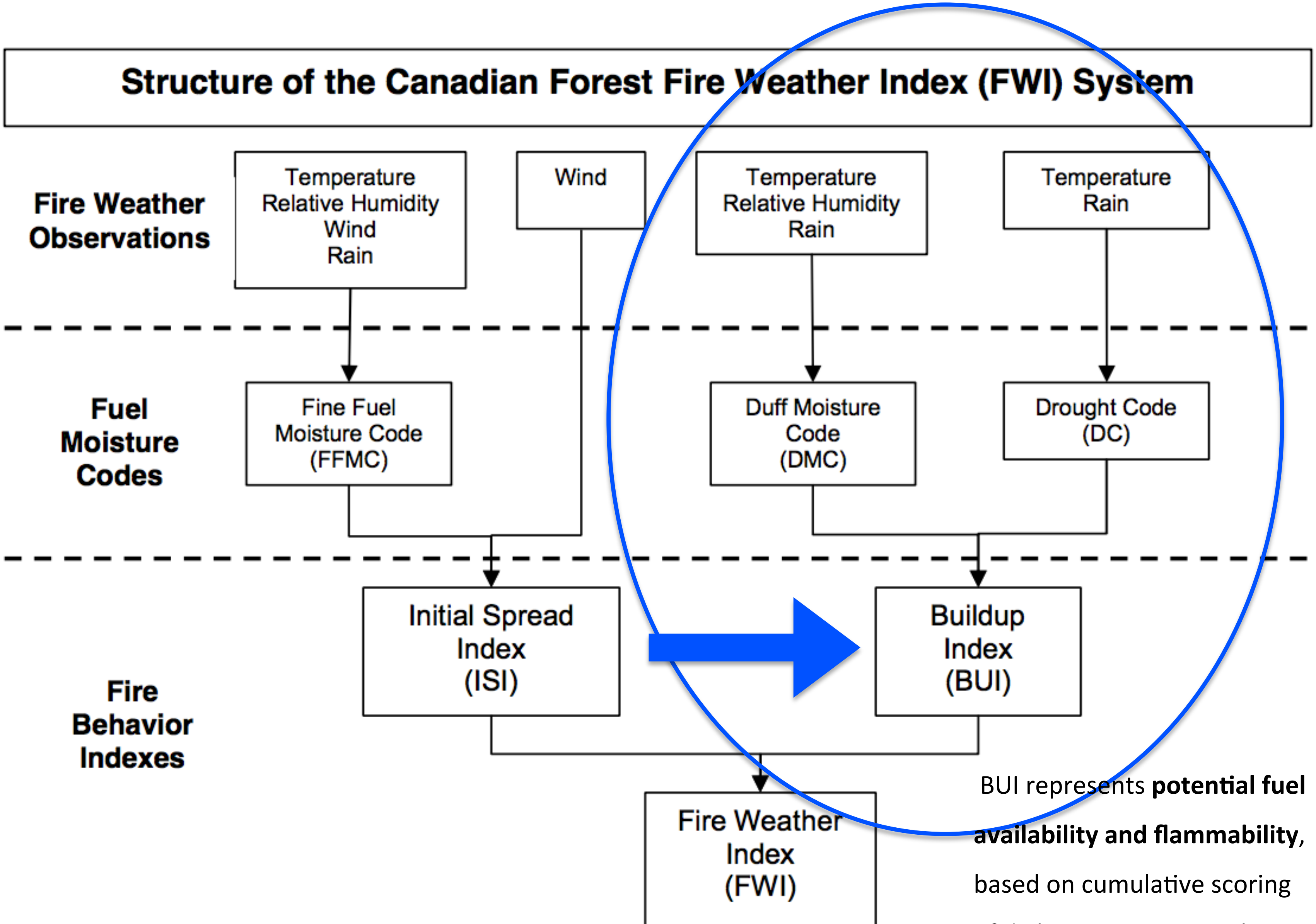


Attribution of 2015 Fire Season to human activities? YES

Partain et al. (2016, BAMS Extremes Issue) - for Alaska

Abatzoglou and Williams (2016, PNAS) - same conclusion for western US

Canadian Forest Fire Weather Index System



BUI represents **potential fuel availability and flammability**, based on cumulative scoring of daily temperature, relative humidity, and precipitation."

[De Groot 2004]

Canadian Forest Fire Weather Index System

Fire fighter field-use table

Summer-Spruce Calibration

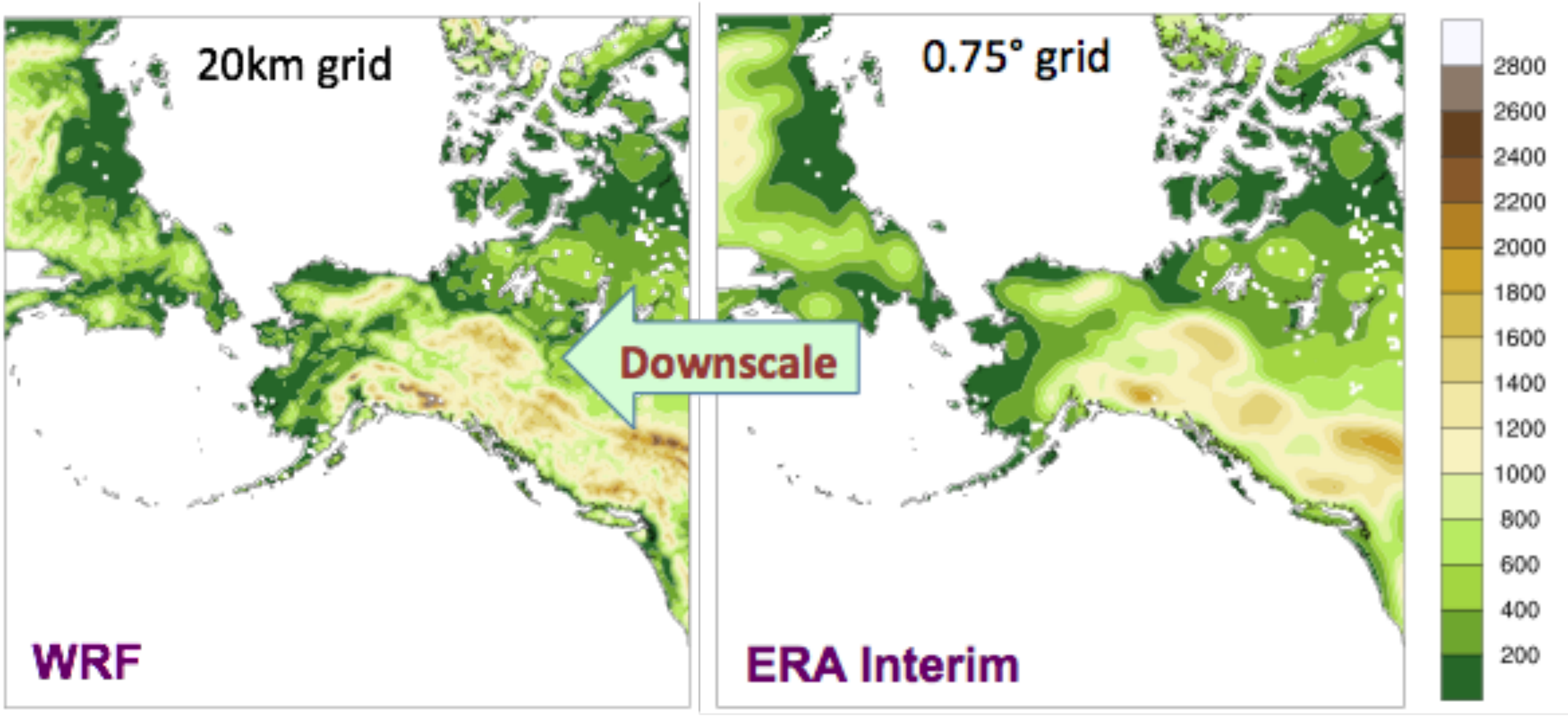
- Buildup Index & Fine Fuel Moisture Code are first factors
- Air Temp
- Fire Weather Index

<table>
<tr><th>SPRUCE (Summer)</th><th>BUI < 40.0</th><th>BUI 40.0 to 59.9</th><th>BUI 60.0 to 89.9</th><th>BUI 90.0 to 109.9</th><th>BUI 110.0+</th></tr>
<tr><td>FFMC Less than 80.0</td><td rowspan="4">LOW</td><td rowspan="3">LOW</td><td rowspan="3">LOW</td><td rowspan="2">LOW</td><td>LOW</td></tr>
<tr><td>FFMC 80.0 to 81.9</td><td rowspan="2">MODERATE</td></tr>
<tr><td>FFMC 82.0 to 83.9</td><td rowspan="2">MODERATE</td></tr>
<tr><td>FFMC 84.0 to 85.9</td><td rowspan="2">MODERATE</td><td>MODERATE</td><td rowspan="2">HIGH</td></tr>
<tr><td>FFMC 86.0 to 88.9</td><td>MODERATE</td><td rowspan="2">HIGH</td><td>HIGH</td></tr>
<tr><td>FFMC 89.0 to 89.9</td><td rowspan="5">HIGH</td><td rowspan="4">HIGH</td><td rowspan="2">VERY HIGH</td><td rowspan="2">VERY HIGH</td></tr>
<tr><td>FFMC 90.0 to 91.9</td><td rowspan="2">VERY HIGH</td></tr>
<tr><td>FFMC 92.0 to 92.9</td><td rowspan="4">VERY HIGH if FWI is less than 36.0
EXTREME if FWI is at least 36.0</td><td rowspan="4">VERY HIGH if FWI is less than 28.0
EXTREME if FWI is at least 28.0</td></tr>
<tr><td>FFMC 93.0+ and Temp < 75.0</td><td rowspan="3">VERY HIGH if FWI is less than 36.0
EXTREME if FWI is at least 36.0</td></tr>
<tr><td>FFMC 93.0+ and Temp 75.0 to 79.9</td><td rowspan="2">VERY HIGH if FWI is less than 40.0
EXTREME if FWI is at least 40.0</td></tr>
<tr><td>FFMC 93.0+ And Temp 80.0+</td><td>VERY HIGH if FWI <40
EXTREME if FWI is at least 40.0</td></tr>
</table>

- Data needed: early afternoon values of
  - 2-m air temperature
  - relative humidity
  - 10-m winds
  - daily total precipitation.

Panel displays categories of fire danger for spruce (http://mesowest.org/akff/captures/InteriorSpruce.png) based on the indices.

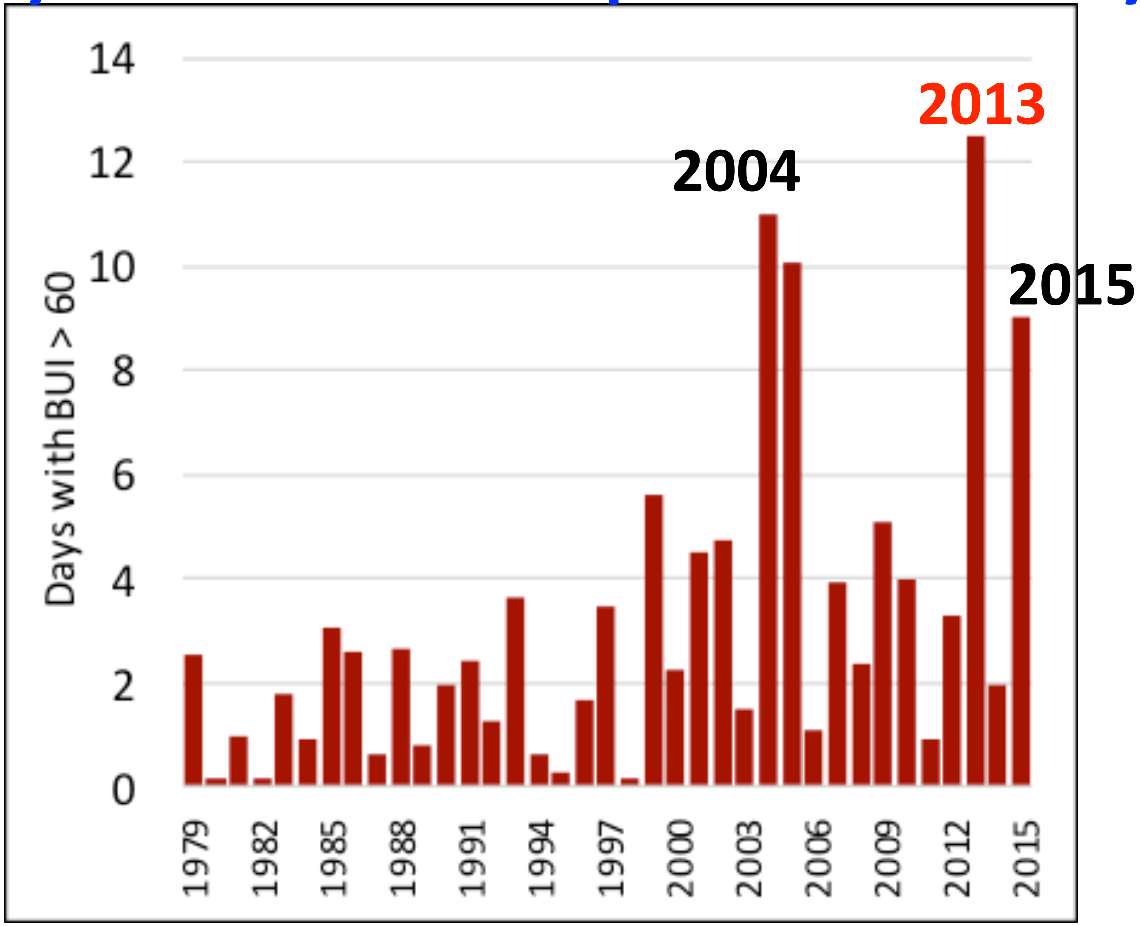
Dynamical Downscaling



- WRF has more detailed terrain
- Reanalysis has broader high elevation areas
- Better resolves mesoscale features
- Downscaled temperature and precipitation more realistic
- Hourly data available

[Bieniek et al. 2016]

Regional # of days with BUI >60 captures extreme years



- **2013 was hot and dry so high BUI, but had few ignitions so few fires**

Tools to Forecast Fire Likelihood

Weather

TOOLS

1. Forecasts of BUI
2. Forecasts of Ignition

Ignition

Fuel

[TS Rupp]

Study Data

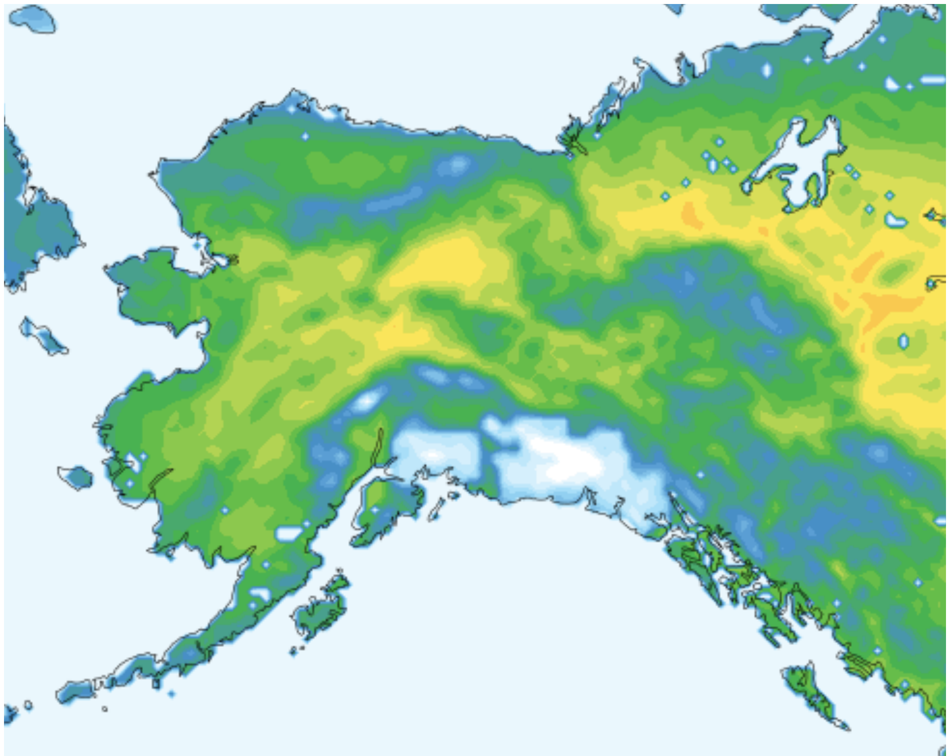
- Apply NMME (Kirtman et al. 2014) seasonal forecasts to wildland fire products in Alaska. NMME forecasts available for 1982-2018. Focus on NOAA CFSv2.
- 'Observations' - Dynamically downscaled ERA-Interim for Alaska . **[Bieniek et al. 2016]**
- Calculate Canadian Forest Fire Weather Indices.
- Most acres burned are remote and lightning provides ignition. Lightning data is collected by BLM.

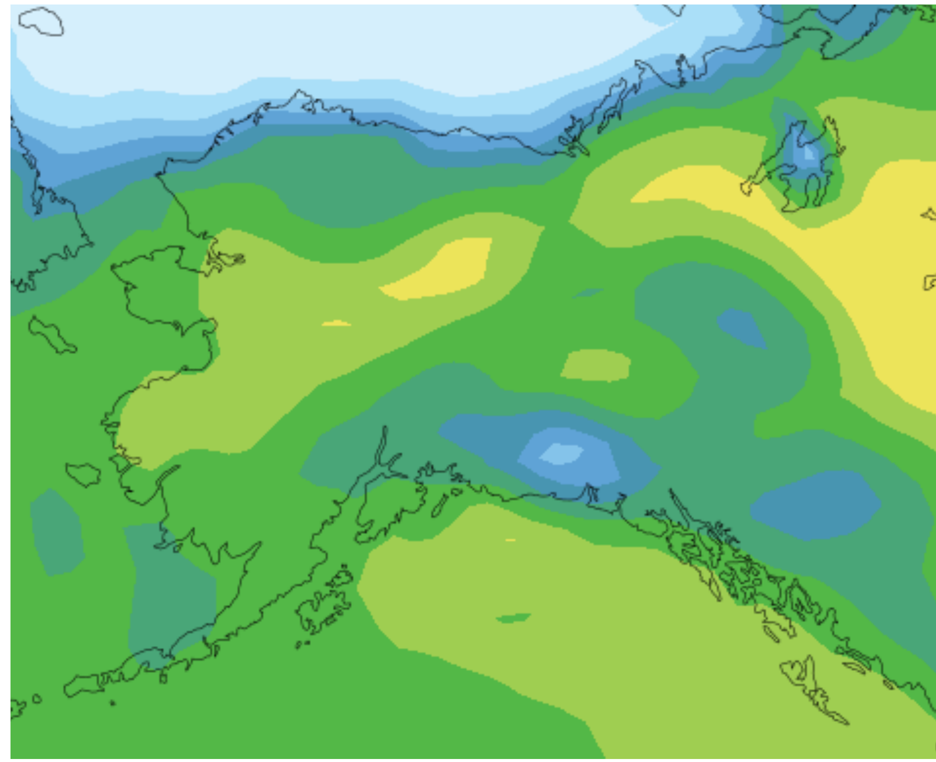
Climatological 2-m Temperature: spatial details missing

JULY

‘Observations’
(Downscaled Reanalysis)

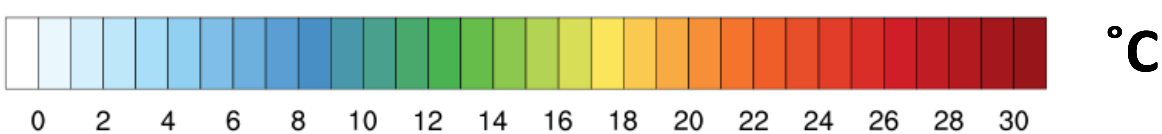
Forecast - March Start





20 km Resolution

100 km Resolution

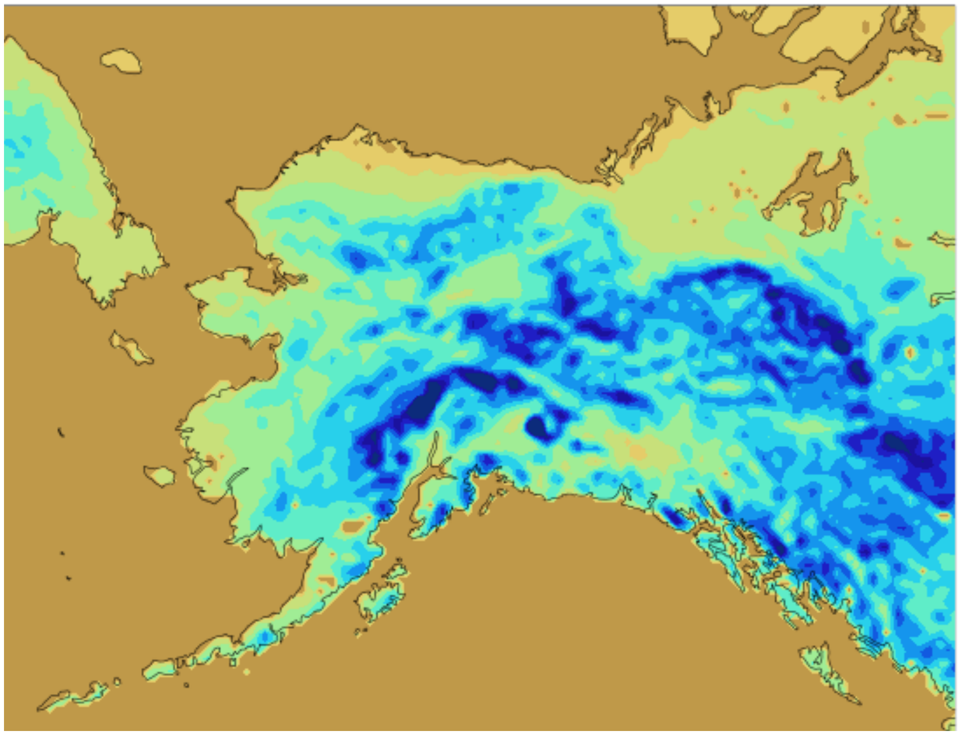


Climo July Precipitation: spatial details missing

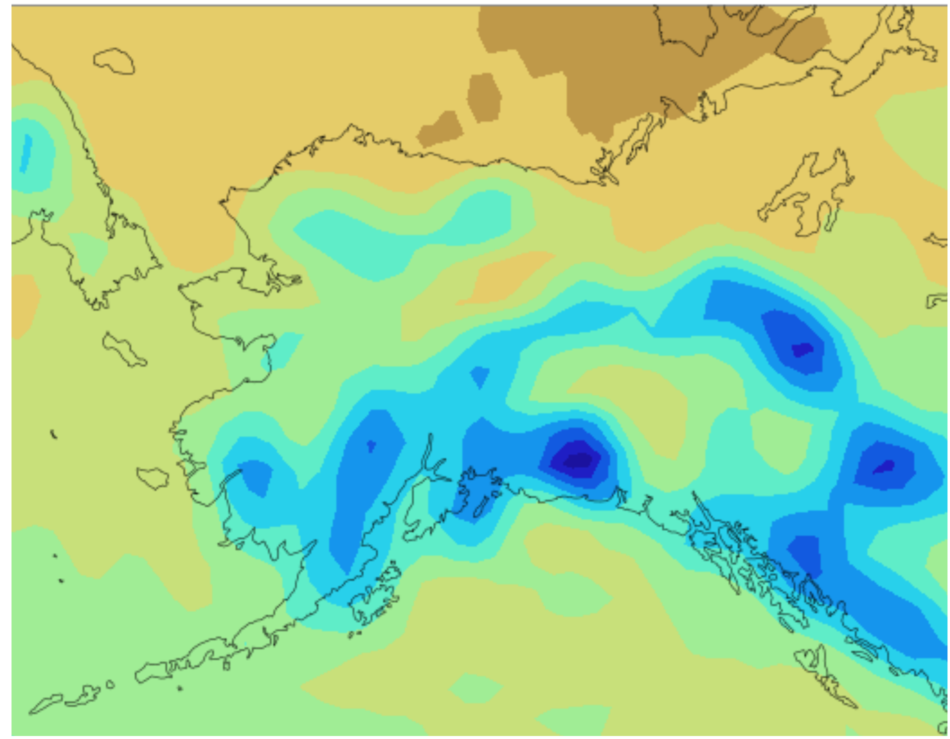
JULY

'Observations' (Downscaled Reanalysis)

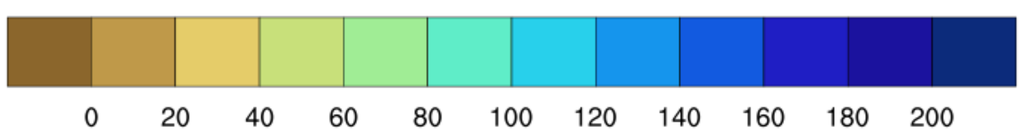
Forecast - March Start



20 km Resolution



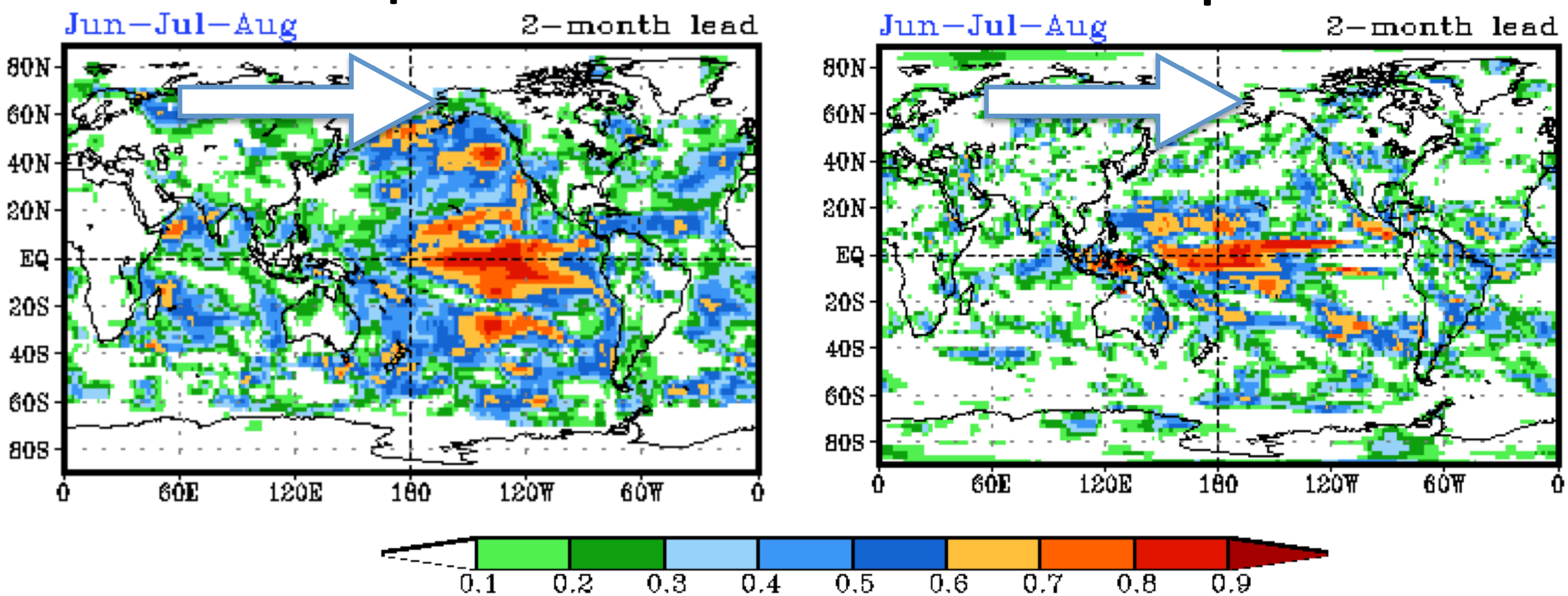
100 km Resolution



mm/month

CFSv2 Correlation Skill Map June-Aug

Temperature **Precipitation**



Skill is highest in July

The skill is calculated based on 15-member ensemble average for each initial month fr

NWS/NCEP

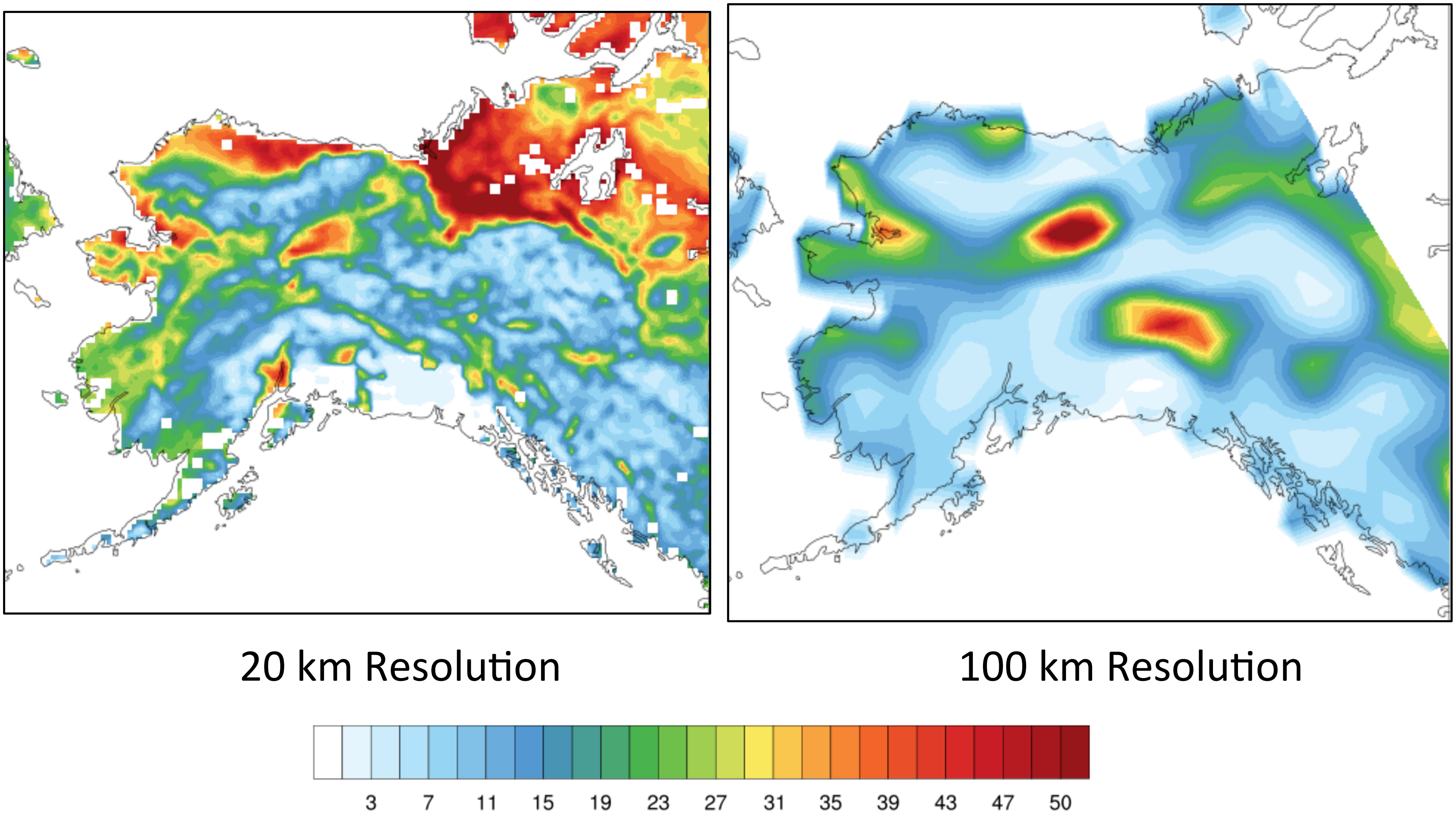
http://www.cpc.ncep.noaa.gov/products/people/wwang/cfs_skills/

BUI Climatology: Too small in Forecast

JULY

‘Observations’ (Downscaled Reanalysis)

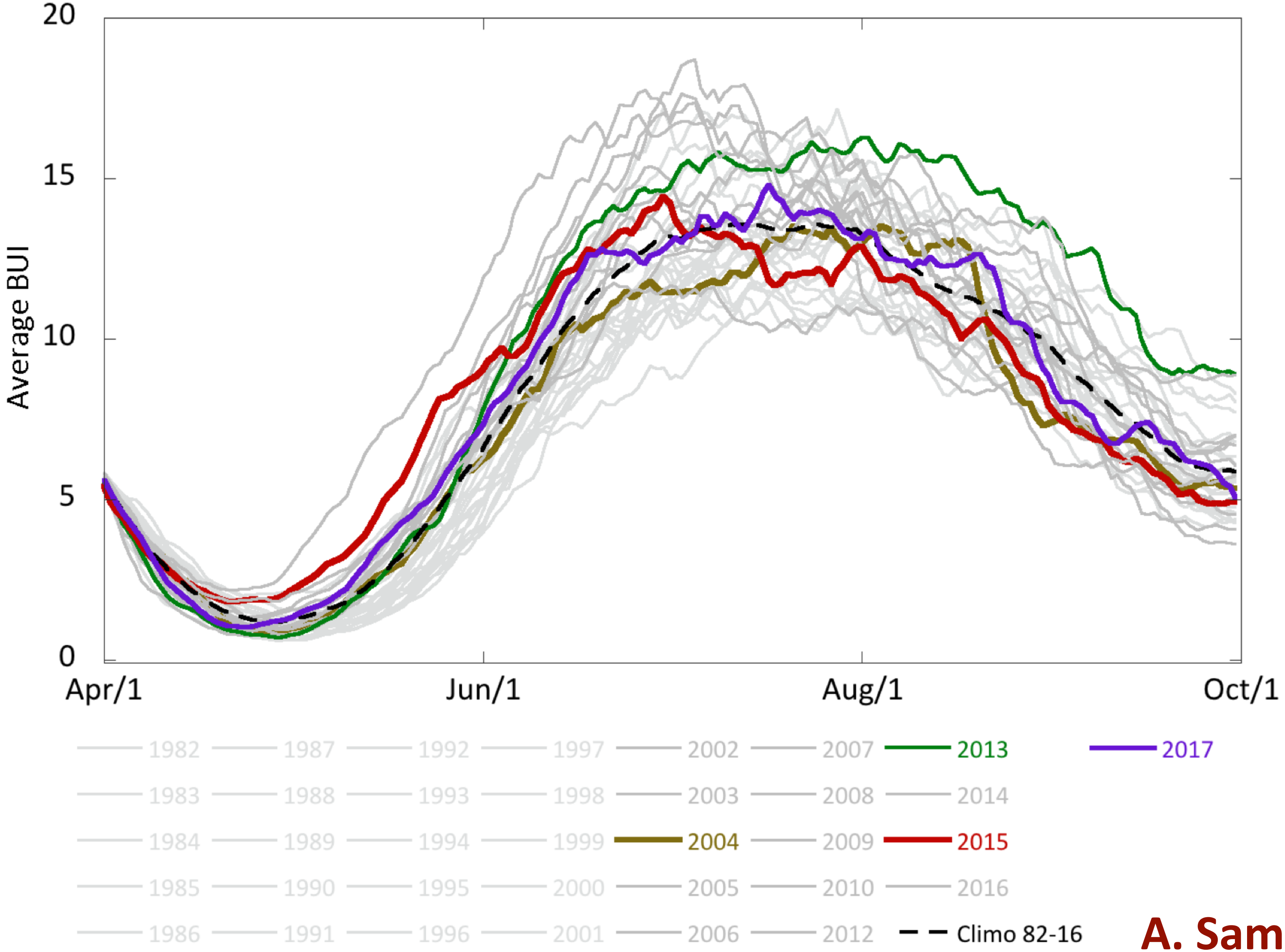
Forecast - March Start



20 km Resolution

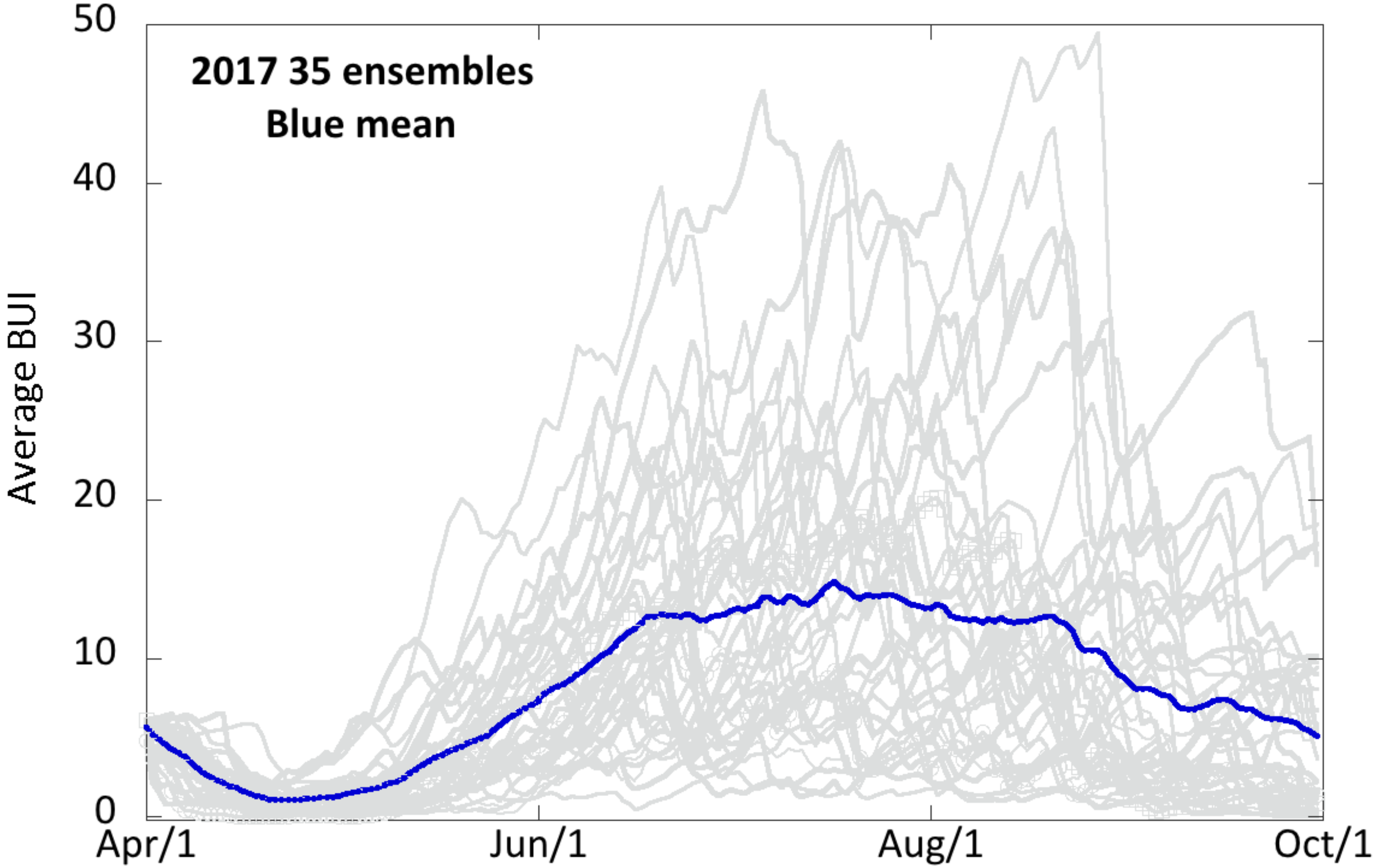
100 km Resolution

CFSv2 BUI for Interior Alaska

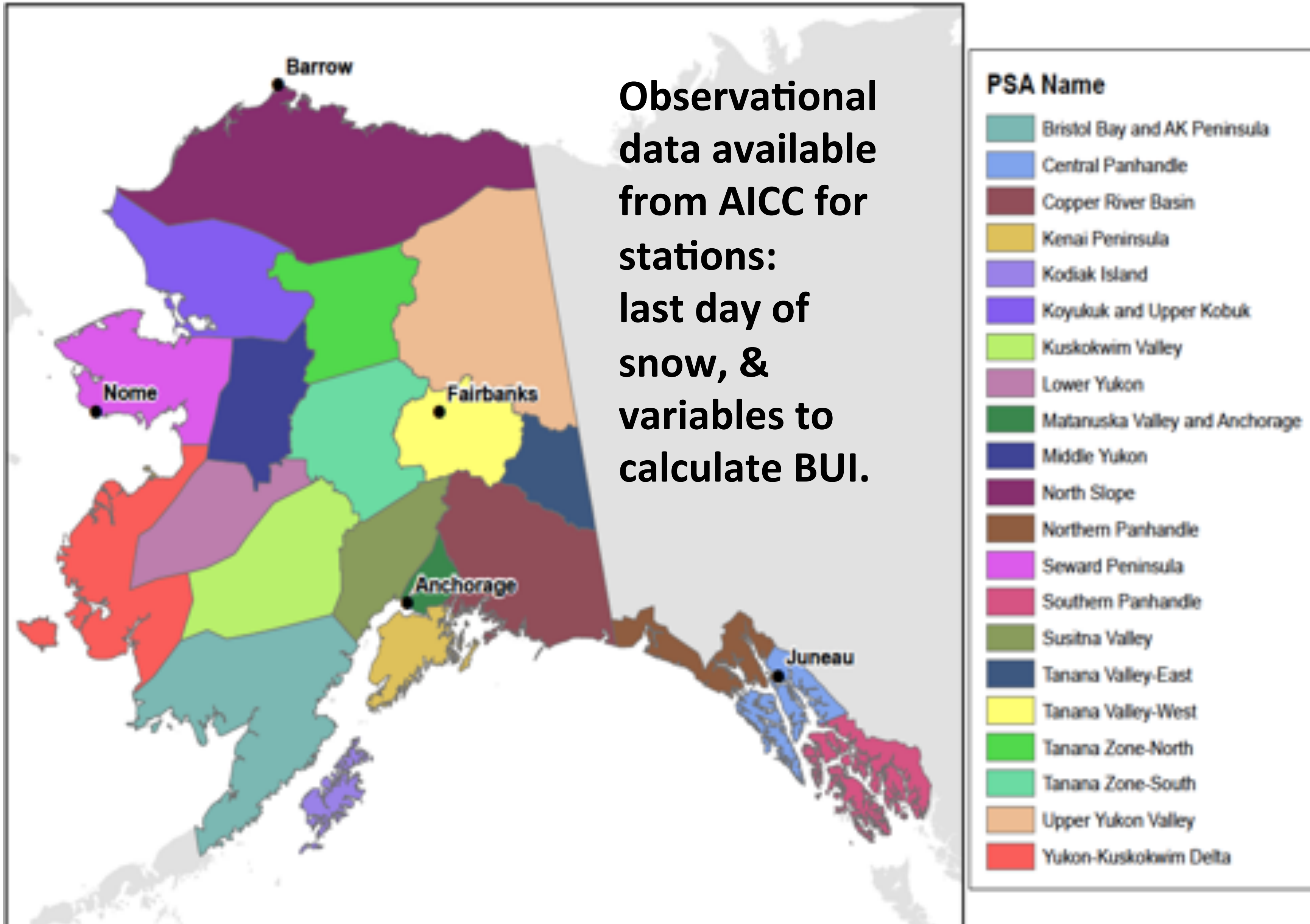


A. Sampath

2017 March Forecast Average Interior BUI

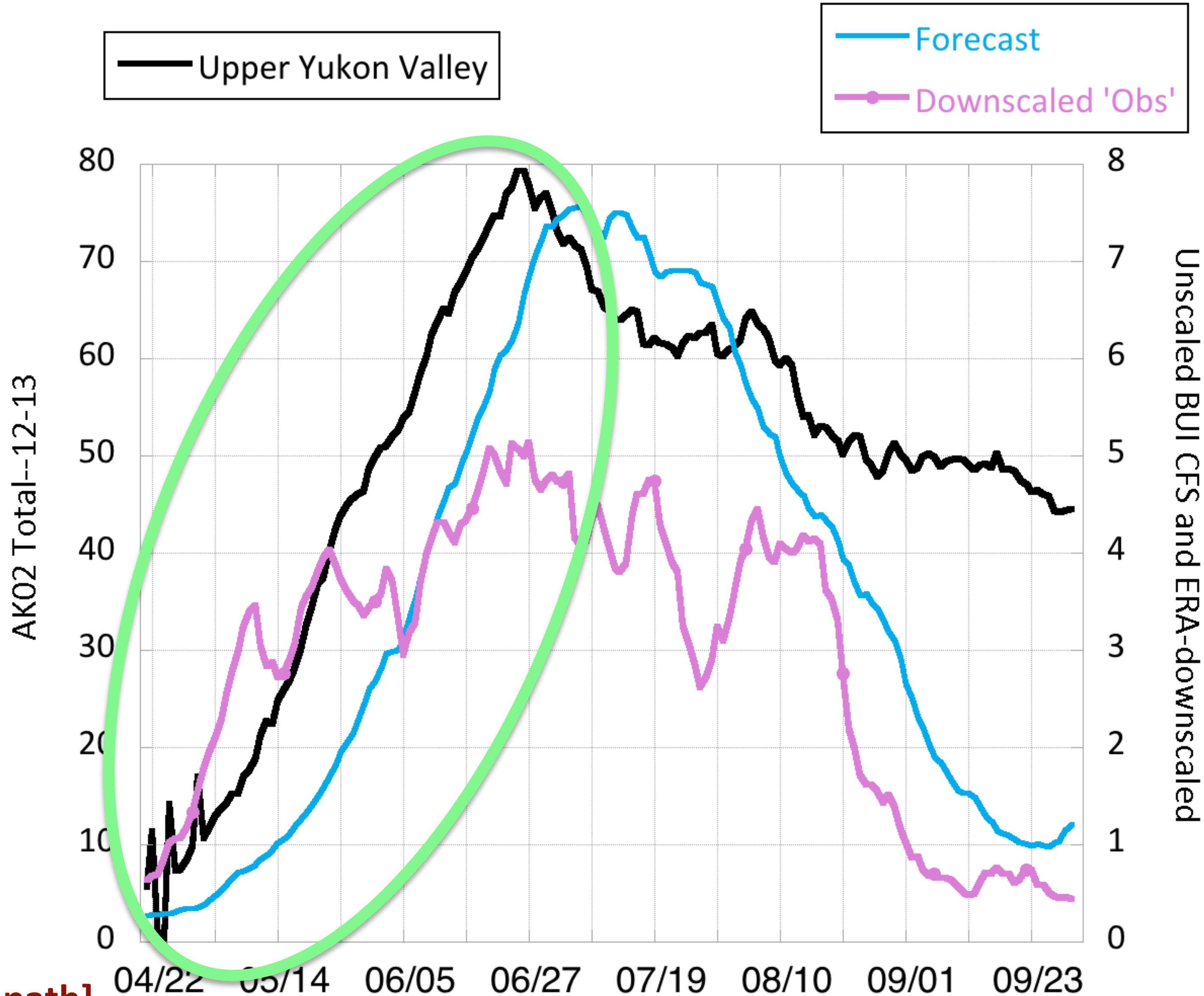


Predictive Service Areas - Use to Divide Domain



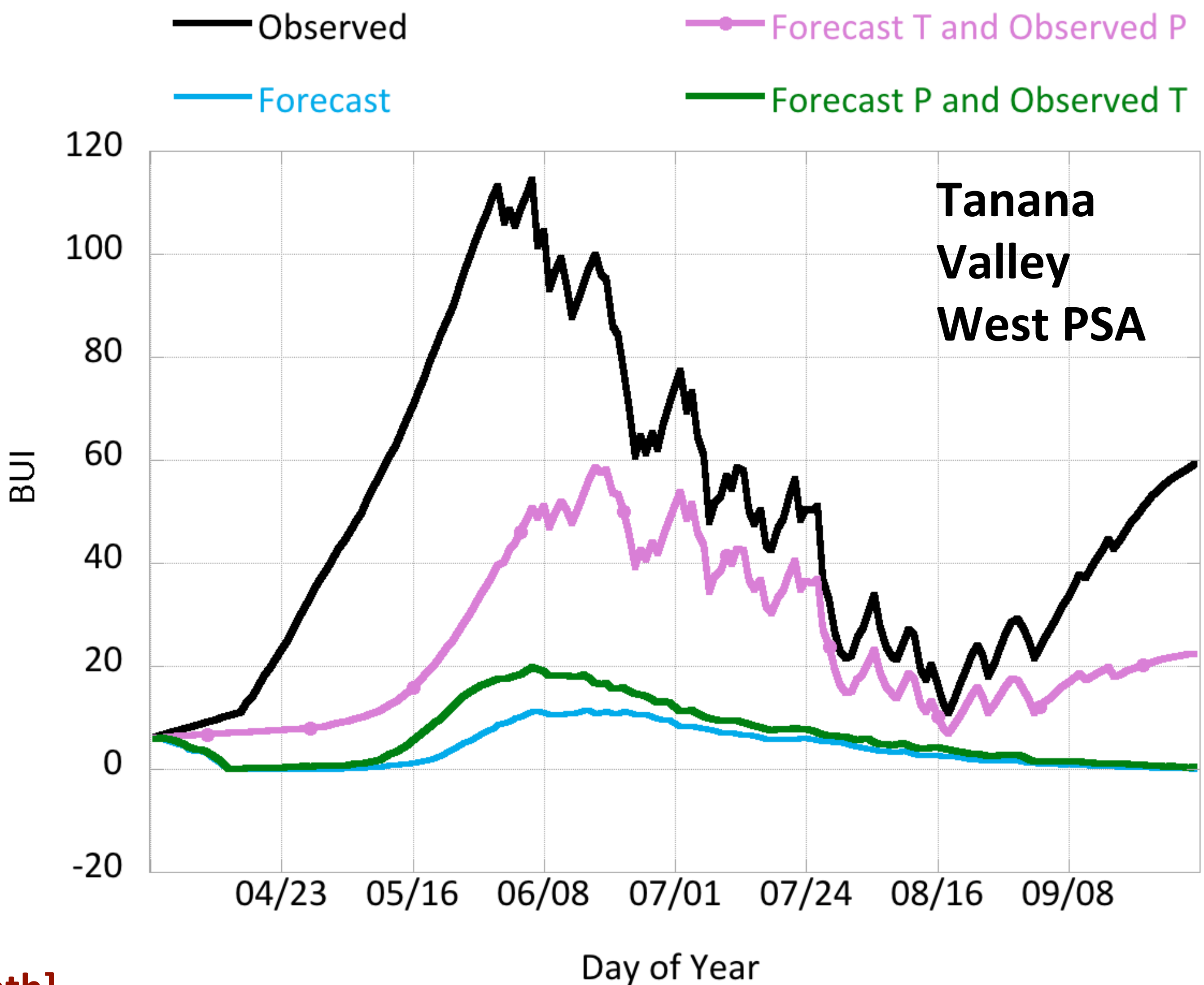
**Observational data available from AICC for stations:
last day of snow, &
variables to calculate BUI.**

Seasonal BUI low in spring for PSA: 2015



[Akila Sampath]

BUI more sensitive to Precipitation bias than Temperature Bias: 2015



[Akila Sampath]

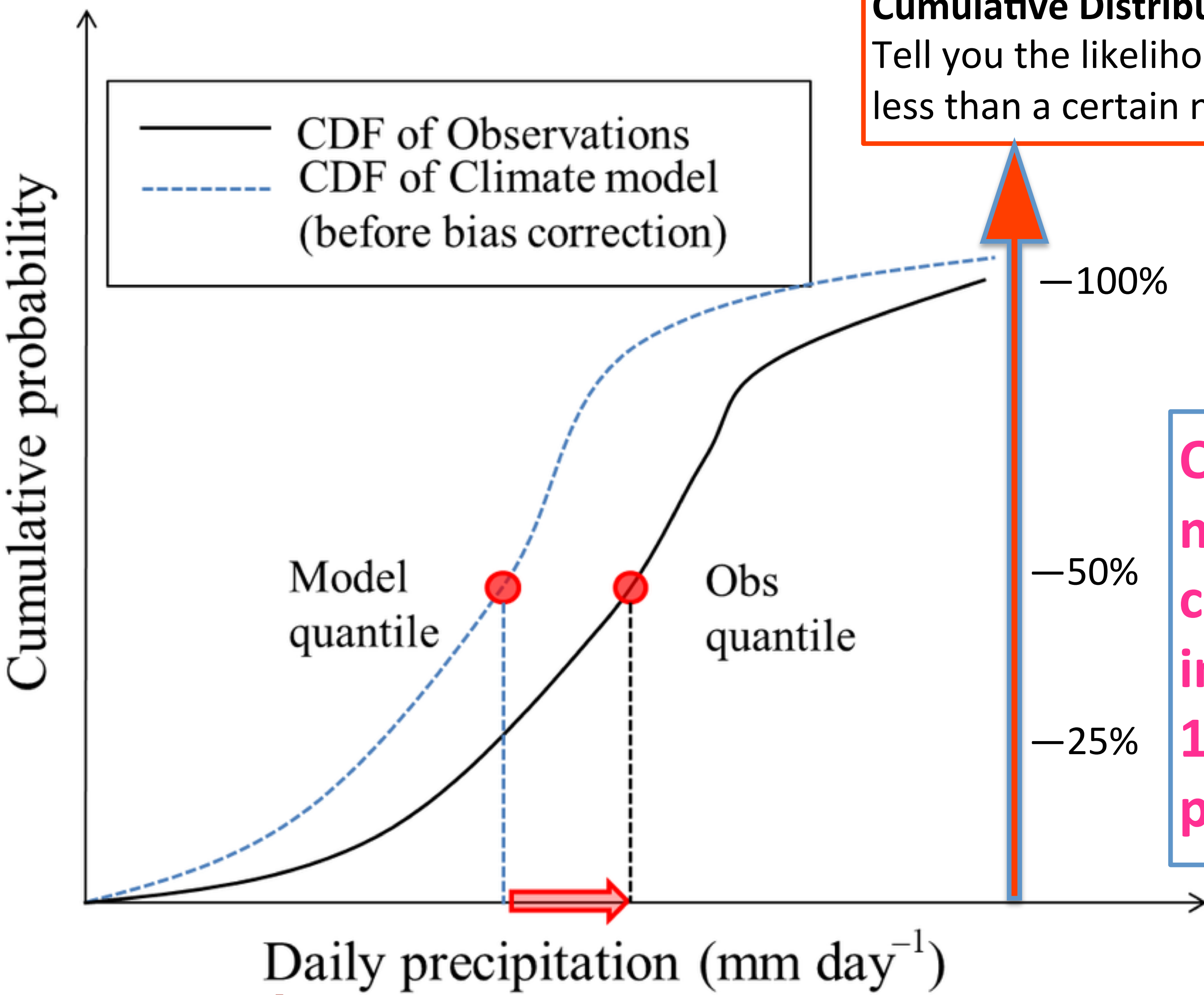
Must Correct Biases in Forecast: At PSA Scale

Correct Forecast Model Bias

- Use PSA averaged station data as ‘true observations’
- Apply Quantile Mapping to determine corrections
- Correct Temperature and Precipitation from Forecast

Quantile Mapping: Make forecast data distribution match observed distribution

Cumulative Distribution Function (CDF)
Tell you the likelihood of having a value less than a certain number.

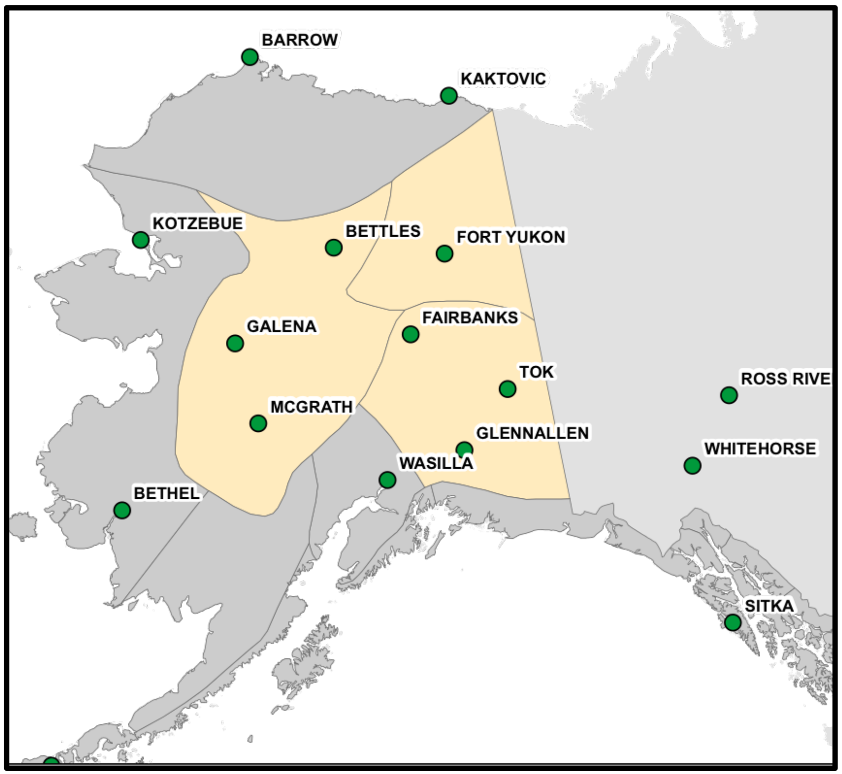


Quantile mapping corrections in progress using 1994-2010 period.

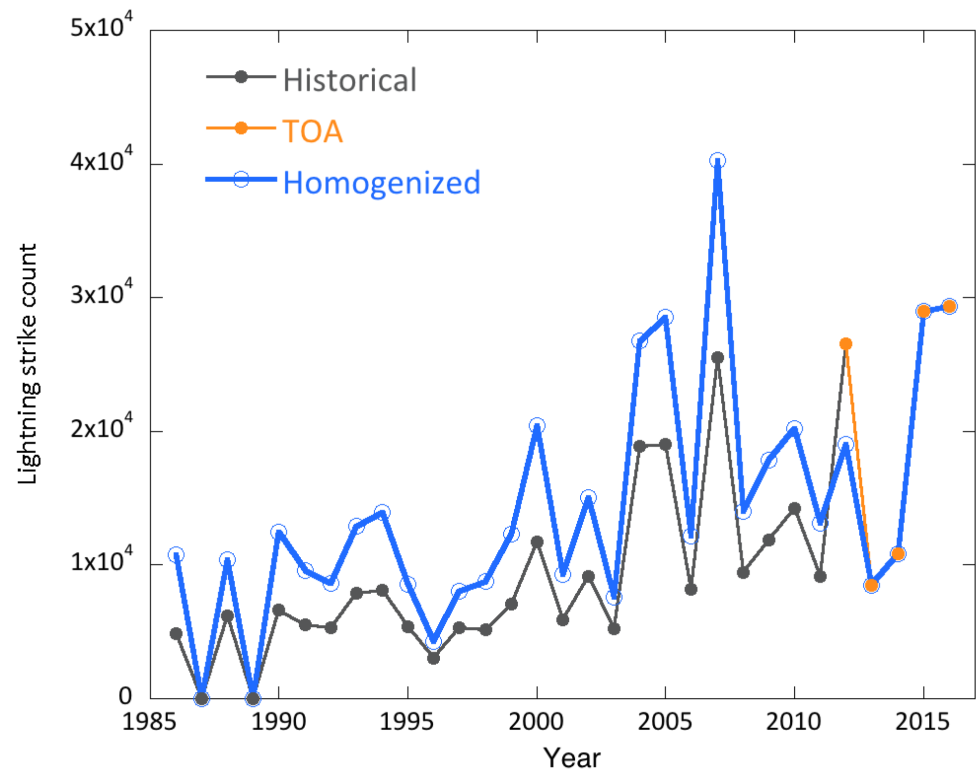
[Kwon et al. 2016]

Lightning Data - Simple Homogenization

Lightning Sensors



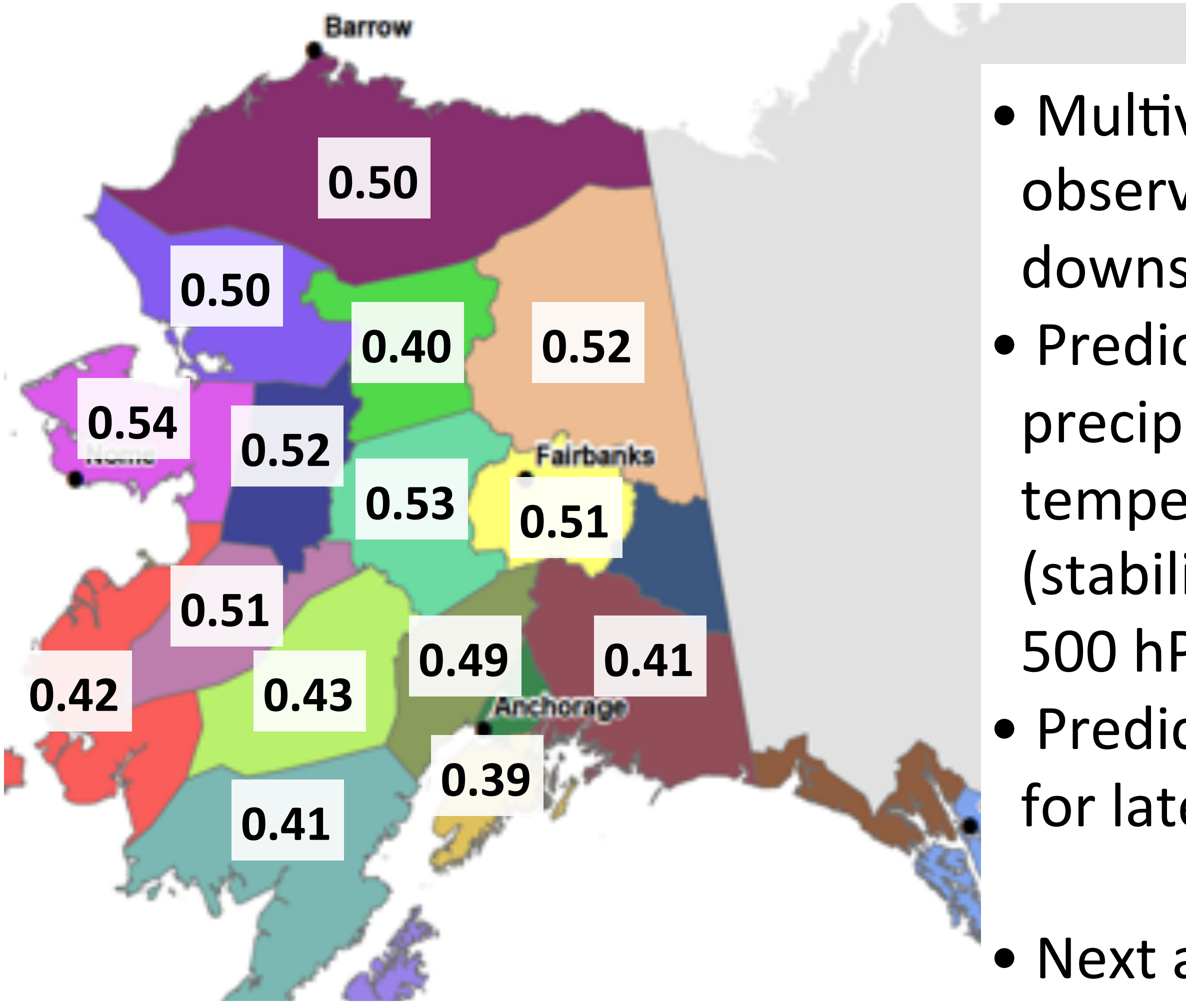
May-August Interior Lightning Strike Counts



Interior Alaska Convective Precipitation Correlated with Strike Counts

[Peter Bieniek]

Meteorological Variables used to Predict Lightning Strikes



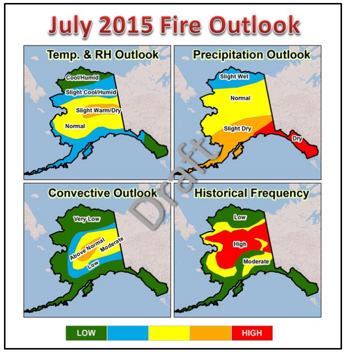
- Multivariate Regression, observed lightning strikes & downscaled ERA-Interim
- Predictors: convective precipitation, vertical temperature gradient (stability), Tdew, 2m-Tair, & 500 hPa height
- Predictive skill (correlation) for late May to mid-July

- Next apply to forecasts

[Peter Bieniek]

Way Forward…

- Develop seasonal guidance using corrected BUI forecasts and lightning strike forecasts
- Identifying biases in the models will help us contribute towards model improvements
- Understanding the model skill will help us communicate forecasts to fire managers
- Multidisciplinary team needed to co-produce useful products



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